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Evaluation of the Push-pull Model on the Effect of COVID-19 on the Employment Stability in the Private and Informal Sector in parts of Lagos State, Nigeria

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ABSTRACT: This study tends to examine the push-pull model on the effect of covid-19 on the employment stability in the private and informal sector in parts of Lagos state, Nigeria. Survey method was adopted and population was drawn from employees across the low income private and informal sector in some of the LGA of Lagos state, Nigeria. Questionnaire was sent through the Google form via e-mails and WhatsApp to about 245 target respondents and 229 was returned completed. A Push-Pull model was developed using stochastic statistical model to obtain the transition probabilities and the stationary distribution. The results revealed that 132, with transitional probability of 0.5788, of low-income private sector employees remain on the job and are willing to pull back to work while 92 individuals with transitional probability of 0.4057 wish to explore other industries and only 5 employees with transitional probability of 0.0165 were ready to defect to other industry.

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The health crisis caused by the COVID-19 pandemic had caused a global economic crisis (Ozili and Arun, 2020), which has created a very strong impact on the labour market, generating a rise in unemployment (Cebrian and Moreno (2018); Mohr (2018); He, *et al*., (2020)). The impact of this crisis was more significant in less developed economies which were considered most vulnerable (McKibbin and Fernando (2020); IFC (2020), UNDP (2020)). The small informal firms particularly SMEs, were badly hit, because of the limited access to resources. Employees in the sector were severely affected (IFC (2020); GSF (2020)). The pandemic has exposed deep-rooted labour market fragilities and structural inequalities, with low-paid workers, young people, women, ethnic minorities, the self-employed and informal and fixed-term workers among the hardest hit by the crisis (ILO-OECD, 2020). It is no longer news that the economic impact of the pandemic was quite devastating to several nations of the world, the worst hit were developing countries like Nigeria, where the informal sector constitute a significant part of the economy. Therefore, the objective of this paper is to employ push-pull model to evaluate the effect of COVID-19 on the employment stability in the private and informal sector in parts of Lagos State, Nigeria.

MATERIAL AND METHODS

Data Collection: Primary data was collected by administering questionnaires via emails and WhatsApp. The study population was drawn from employees across the private and informal sector in some LGA, Lagos state, Nigeria. Out of 245 participants that had questionnaires forwarded to them, only 229 was returned completed on which analysis was based. Purposive sampling is the sampling techniques employed for this study. The internal consistency of the measuring instrument was ascertained using Cronbach's Alpha, which gave a value of .781 that confirmed the internal consistency of the measuring instrument.

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Discrete–Time Markov Chain: A stochastic process in discrete time $n \epsilon N = \{0,1,2,...\}$ is a sequence of random variables $X_0, X_1, X_2, ...$ denoted by X = $\{X_n: n \geq 0\}$. X_n is referred to as the state of the process at time n with X_0 denoting the initial state.

Stochastic process $\{X_n, n = 0, 1, 2, \cdots\}$ with a finite or countable state is said to be a Markov Chain if for all states $k_0, k_1, k_2, \cdots, k_{n-1}, j$; $k, and\ all\ n \geq 0,$

$$P\{X_{n+1} = k | X_0 = k_0, X_1 = k_1, \cdots, X_{n-1} = k_{n-1}, X_n = j\} = P\{X_{n+1} = k | X_n = j\} \quad (1)$$

The equation above is called the Markov Property. Where $P\{X_{n+1} = k | X_n = j\}$ are known as one-step transition probabilities. (Eledum, 2018).

If $P\{X_{n+1} = k | X_n = j\}$ is independent of n, the Markov chain is said to possess Stationary Transition Probabilities (Kasumu, 2002) with

$$P_{jk} = P\{X_{n+1} = k | X_n = j\} \quad (2)$$

The transition probabilities is given as

$$\begin{array}{ccc} & \begin{matrix} R & E & D \end{matrix} & = P_{j.} \\ P_{jk} = & \begin{pmatrix} P_{11} & P_{12} & P_{13} \\ P_{21} & P_{22} & P_{23} \\ P_{31} & P_{32} & P_{33} \end{pmatrix} & \begin{matrix} P_{1.} \\ P_{2.} \\ P_{3.} \end{matrix} \\ P_{.k} & \begin{matrix} P_{.1} & P_{.2} & P_{.3} \end{matrix} & P_{..} \end{array} \quad (3)$$

Each row is a probability vector,

$$\sum_{k=1}^{3} P_{1.} = \sum_{k=1}^{3} P_{2.} = \sum_{k=1}^{3} P_{3.} = P_{j.} = 1 \quad (4)$$

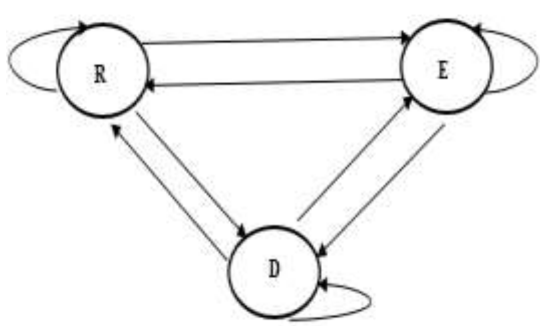

Fig 1: A model of transition between states

If two states, say $i\ and\ j$ are accessible from each other, then we say that they communicate and we write $i \leftrightarrow j$ (Klappenecker, 2018). In Figure 1 above, following the arrows, it shows that it is possible to go from one state to the other. In essence, the states communicate which means there is only one class. A Markov chain is irreducible if there is only one class (Sheldon, 2010). Thus the chain is irreducible.

The stationary distribution of a Markov chain, also known as the steady state distribution, describes the long-run behavior of the chain. Morison (2015) opines that this is the most interesting aspect of Markov chain. Let $A = P_{jk}$, then

$$X_1 = AX_o$$
$$X_2 = AX_1 = A^2 X_o$$
$$X_3 = AX_2 = A^3 X_o$$

$$X_n = AX_{n-1} = A^n X_o \quad (5)$$

Thus, the nth transition, given by X_n, the state of the process at time n, equals the n^{th} power of the one step transition A and the initial state X_o. (Kasumu, 2002).

A stochastic matrix does not necessarily have a *unique* steady state vector. In other words, a system modeled by a Markov Chain can have more than one equilibrium. However, for a regular stochastic matrix, P converges to the steady state π independently of the initial state. (Morison, 2015; Eledum, 2018).

$$\lim_{n \to \infty} P^n = \pi \quad (6)$$

The state probability vector $\pi = [\pi_1 \quad \pi_2 \quad \pi_3]$, where π_1 is the probability that an individual remains in the same field or industry in the long run. Also,

$$\pi P = \pi \quad (7)$$

Another basic property of stationary distributions:

The Push-Pull Model Assumption: We consider a low-income private organization where there is a regular movement of employees in and out of the organization. The total population is divided into *m* homogeneous groups and these groups form a partition of the total population *N*. The number of employees in group i at time t is denoted $n_i(t)$.

The push pull model adopted for this study is based on the assumption that the transition of employees from one state to another is determined by the measurement factor a, such that

$$X_{t+1} = aX_t \quad (8)$$

Where a is a model parameter that specifies the ratio between the current state X_t and the next state X_{t+1}.

In reality, an employee stays on a job before s/he decides whether to remain on the job, explore or defect out rightly. The length of one time interval is such that an employee can make at most one transition during the time interval. Thus employees that will be at any of the three states in the next time interval are determined by the measurement factor in the last time period plus the level of consistency of income. The consistency of income is taken as a constant factor as opined by Silaban and Rahmat (2018) that the level of consistency of income will greatly impact on employees' turnover rate. We model these movements by a discrete-time discrete-space Markov Process. The model is given as

$$y_t = a y_{t-1} + c \qquad (9)$$

Where y_t is the number of employees in the current time. a is the ratio of the number of employee in group i to the total population; a (1x3) row vector. y_{t-1} is a (3x3) matrix of the population of employees in each group in the last time period. c is rate of change of consistency of income, a (1x3) row vector.

Now, let us consider a, the ratio of the number of employee in group i to the total population; we write a as

$$a = {}^{n_i}\!/_{N} \qquad (10)$$

Where n_i is the subtotal of employees in group i, and

$$N = \sum_{i=1}^{m} n_i = n_1 + n_2 + n_3 + \cdots + n_m \qquad (11)$$

The number of employees in the next state comprises those employees available for the job, that is the supply of labour, which is taken as the push effect; it is from this lot that some are actually demanded for and pulled to the job; this explain the Push-Pull model. The model can be written as:

$$y_t = {}^{n_i}\!/_{N}\, y_{t-1} + c \qquad (12)$$

Equation 12 is the equation for determining the estimate for number of employees in the next state under the Markovian assumption. Also, we assume that the Push effect (supply of labour) equals the Pull effect (demand for labour) and therefore $c = 0$. thus, the model becomes

$$y_t = {}^{n_i}\!/_{N}\, y_{t-1} \qquad (13)$$

RESULTS AND DISCUSSION

The measurement factor a, is the model parameter that specifies the ratio between the current state and the next state. The product of the ratio and the population of employees in the last period give an estimate of the number of employees in the next period.

The pooled estimate transition count matrix is obtained as a:

$$y_t = \begin{pmatrix} 28 & 13 & 0 \\ 19 & 22 & 2 \\ 27 & 94 & 20 \end{pmatrix} \qquad (14)$$

Which is the population of employees in the current state. The transition probability matrix for the pooled estimates is

$$A = \begin{matrix} \\ R \\ E \\ D \end{matrix} \begin{matrix} \begin{matrix} R & \quad E & \quad D \end{matrix} \\ \begin{pmatrix} .6801 & .3199 & 0 \\ .4486 & .5166 & .0349 \\ .1918 & .6656 & .1426 \end{pmatrix} \end{matrix} \qquad (15)$$

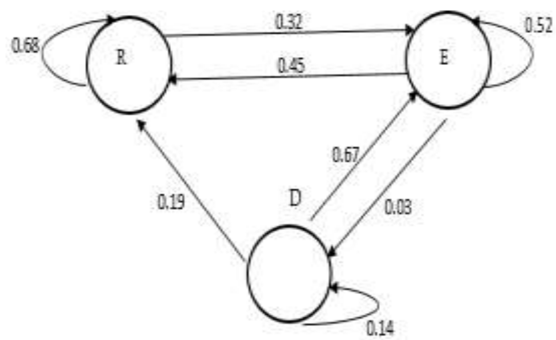

Fig 2: Transition probabilities between states

The transitional probability graph describes the conditional probabilities of moving from the current state to the next state. The conditional probability that an employee will explore given that he is currently on the job is 0.32 and it is 0.45 otherwise. Also, the conditional probability that an employee will return and remain on the job given that he currently defects is 0.19 while the conditional probability that an employee will explore given that he currently defects is 0.67 and 0.03 otherwise.

Using the model, given in (12) above, the estimate for number of employees in the next state is

$$y_{t+1} = \frac{1}{N}(74 \quad 129 \quad 22)\begin{pmatrix} 28 & 13 & 0 \\ 19 & 22 & 2 \\ 27 & 94 & 20 \end{pmatrix}$$

$$y_{t+1} = (23 \quad 26 \quad 3) \qquad (16)$$

y_{t+1} above indicates that 23 (that is 44%) of the estimated number of employees in the next period will remain on the job while 26 (that is 50%) will explore and only 3, which is 6%, will defect.

The push-pull model developed for study determines an estimate number of employees in the next time period which actually comprise those employees that either remain explore or defect with the pull back to work from employers, in the case of a crisis like Covid-19. This is a push-pull effect.

Using Maple17® to determine the probability for the steady state, we have

$$> A := \begin{bmatrix} .6801 & .3199 & 0 \\ .4486 & .5166 & .0349 \\ .1918 & .6656 & .1426 \end{bmatrix}$$

$$\begin{bmatrix} 0.6801 & 0.3199 & 0 \\ 0.4486 & 0.5166 & 0.0349 \\ 0.1918 & 0.6656 & 0.1426 \end{bmatrix} \quad (17)$$

Push-Pull Transitional Probability Matrix

$B1 := A^2$

$$\begin{bmatrix} 0.606043150000000 & 0.382824330000000 & 0.0111645100000000 \\ 0.543533440000000 & 0.433612140000000 & 0.0230060800000000 \\ 0.456382020000000 & 0.500120340000000 & 0.0435642000000000 \end{bmatrix} \quad (18)$$

$B := A^3$

$$\begin{bmatrix} 0.586046293771000 & 0.399071350419000 & 0.0149526282430000 \\ 0.568588064692000 & 0.413193225828000 & 0.0184137306940000 \\ 0.543095009886000 & 0.433355107362000 & 0.0236664547860000 \end{bmatrix} \quad (19)$$

$C := A^5$

$$\begin{bmatrix} 0.578902076503336 & 0.404873075550522 & 0.0163753864080205 \\ 0.577576932807197 & 0.406044025051846 & 0.0166561429896911 \\ 0.575482947228103 & 0.407654094183287 & 0.0170642021067894 \end{bmatrix} \quad (20)$$

$F := A^{10}$

$$\begin{bmatrix} 0.578396718964648 & 0.405453650701206 & 0.0165028019374363 \\ 0.578467474573808 & 0.405507044316040 & 0.0165053965867461 \\ 0.578420031827799 & 0.405479351854970 & 0.0165048875086778 \end{bmatrix} \quad (21)$$

Below is the graphical concept of the steady state distribution to the 10th iteration.

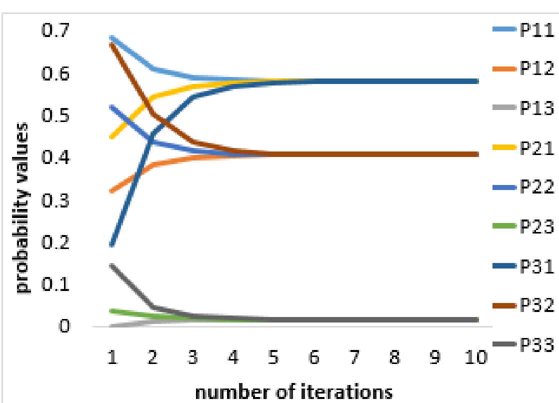

Fig 3: Steady state graph

The state of equilibrium was attained, at the 5th iteration, going further to the 10th iteration was in the bid to establish that the steady state that has been achieved. The main feature in the study of Markov

$> F13 := MatrixMatrixMultiply(E, A)$

chain long term behaviour, predicting the distant future, is the most interesting aspect of Markov Chain (Morison, 2015). The state converged reasonably quickly, at the 5th iteration, as shown in the steady state graph above.

The quick convergence is an actual reflection of the readiness of employees in the LIPS to return and remain after the initial and overwhelming shock of the 1st wave of the pandemic. The advent of the 2nd and 3rd waves of Covid-19 was not as shocking, because there was a measure of stability in the general populace and among workers in various sectors.

The rounded values of the steady state probabilities are given in the set E as shown below:

$$> E := \begin{bmatrix} .5788 & .4057 & .0165 \end{bmatrix}$$

$$\begin{bmatrix} 0.5788 & 0.4057 & 0.0165 \end{bmatrix} \quad (22)$$

The analysis below is to give credence to the claim in (7) above; where E is the stationary probability π and A is the transitional probability.

$$\left[\ 0.578803600000000\ \ 0.405725140000000\ \ 0.0165118300000000\ \right] \quad (23)$$

Thus,

$$\pi P = \pi$$

$$[.5788 \quad .4057 \quad .0165]\begin{pmatrix} .6801 & .3199 & 0 \\ .4486 & .5166 & .0349 \\ .1918 & .6656 & .1426 \end{pmatrix} = [.5788 \quad .4057 \quad .0165] \quad (24)$$

The steady state probability for the Push-Pull effect is $[.5788 \quad .4057 \quad .0165]$, this was achieved at the 5th iteration. This, by implication, means that in the long run, 58% of low-income private sector employees will likely remain on the job and willing to pull back to work while 40% will likely explore other industries and only 2%, with transition probability of 0.0165 are likely to defect to another industry.

The result obtained in (16) using the model gave realistic result of the lockdown in the heat of 1st wave compared to the steady state probability for the pooled estimates that took into cognizance the 2nd and 3rd waves. The concerns of the 2nd wave was more in the health sector and not as overwhelming in other sectors as the 1st, the same with the 3rd wave. Many economies in the world had recovered Daube (2021) with varying factors beyond the scope of this study. However, with the unequal impact of the crisis, particularly, its effect on low-income earners in the private and informal sector, many have returned to their jobs in the New Year January 2021 bargaining for a better working condition, to ensure stability of their employment status, some explored other fields in addition and a fractional few defected.

Conclusion: This study result reveals that effect of the shock of the first wave of the pandemic resulted in many, an estimate of 50%, exploring other fields and sectors for alternative sources of income. However, in the long run, having survived the initial shock, many more returned and remain on the job, with an estimate of 44% explore, and only a fractional few to defect in the long run. The results obtained also showed a stochastic view of previous studies, most of which are theory based. The result gave statistical credence to the results obtained in the report on Global Schools Forum 2020, International Finance Corporation. While it may be practically impossible to stop people from migrating to and or exploring other sectors of the economy, government support and policies can help cushion the effects of crisis in the informal sector. Also, job security, which is a rare phenomenon in the informal sector, particularly in the low income private sector LIPS, will go a long way in ensuring stability on the job. The informal sector constitutes a significant part of the economy and no sector should be made to suffer, particularly in the instance of a global pandemic like the Covid-19.

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